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QUANTITATIVE ANALYSIS OF THE PHYSIOLOGICAL CONDITION AND LEVEL OF ALERTNESS OF MAN IN AN ISOLATED ENVIRONMENT

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13. ABSTRACT

The design and fabrication of the electronic detectors necessary for analyzing the animal EEG's and the software for computer processing of the data have been completed. Although analysis of human EEG's are not completed, it has been noted that monitoring the high frequencies present in the frontal channels provide a good indicator of whether or not the subject is awake. This activity appears to provide a more sensitive indicator of alterness than does alpha activity. This research has just entered the stage where it is justifiable to publish some of the findings and two manuscripts are in preparation.

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Quantitative Analysis of the Physiological Condition and Level of Alertness of Man in an Isolated Environment

Introduction:

The objectives of this research program are: To develop an automated technique for monitoring the state of alertness of a subject, to quantify the effects of drugs on cat EEG activity, and to extend the animal research findings to the development of a system for monitoring the physiological condition of man. We have completed the design and fabrication of the electronic detectors necessary for analyzing the animal EEG's and the software has been completed for processing this data in a PDP-8e minicomputer. Although we have not completed our analysis of the human EEG we have found that monitoring the high frequencies present in the frontal channels (probably due to muscle activity) provide a good indicator of whether or not the subject is awake. We have yet to do the detailed studies necessary, but this activity appears to provide a more sensitive indicator of alertness than does alpha activity.

Animal Studies:

Four cats have been implanted with electrodes and sockets capable of providing the long term continous monitoring necessary for this study. Two shielded cages for housing the animals have also been built. For the EEG analysis, spindle (10.5-15.5 Hz), delta (.5-3.5Hz),and rapid eye-movement detectors have been designed and constructed. The rapid eye movement detector has turned out to be necessary because the slow-wave detector (delta) picks up a large amount of activity which is actually eye-movement artifacts; thus the eye-movement detector will be used to inhibit the delta detector during eye-movements. An arousal detector is also being designed. The detectors have all been interfaced with the PDP-8e data acquisition system, and the data reduction software is now being written. When this task is completed, the long term animal studies will commence-probably by November 15.

Human Alertness Studies:

We originally proposed to analyze the EEG to discover a parameter which would permit monitoring the level of alertness of human subjects. This proposal was prompted by our finding a parameter in the cat EEG which apparently corresponded with the animal's level of alertness. Our initial analysis of the human EEG has not turned up brain-wave activity corresponding to the alertness level, but we have been diverted by our observation that the frontal EEG channels contain a large amount of high frequency activity when the subject is alert. It is felt that this activity is probably muscle artifact rather than EEG activity, but since the object is to monitor the level of alertness the origin of this activity is of secondary importance. To analyze this activity we have constructed special hardware which we have interfaced with our PDP-8 data acquisition system.

The analysis system used in this study is shown in Figure 1. The EEG is recorded on magnetic tape and then played back through a 60 Hz notch filter and a zero-crossing detector. The output of the zero crossing detector is thus a digital pulse train at the frequency of the dominant EEG activity. This data is connected to the digital input-output bus of the PDP-8. The computer generates an analog output (via the D/A converter) which is proportional to the average frequency for a selected epoch. We have been studying two and 10 second epochs for the moving average. The analog output is displayed on an oscilloscope and a x-y plotter. The flow chart for the PDP-8 processing is given in Figure 2. Although many investigators have measured the zero-crossings of the EEG, this program differs in two very significant aspects. First of all, we are measuring the high frequency activity. This has normally been excluded from analysis by other investigators as it was considered to be artifact and not of interest. Secondly, our program gives a continous running average over the selected epoch. This permits us to obtain an accurate measure of the frequency without distortion from very high or very low frequency epochs. The application of this system to EEG records which contained both epochs of sleeping and

wakefulness showed that in the three subjects studied that the average frequency in the awake spochs was several times higher than the average frequency during sleep epochs. We now need to more closely analyze the epochs to determine whether or not the decrease in frequency commences before the subject becomes drowsy. To more efficiently carry out this study we are constructing a special purpose hardware system which will perform many of the tasks now assigned to the digital computer.

In the second year of this study we will carry out the long term studies on the laboratory cats. Also we will pursue our findings that the high frequency activity in the EEG corresponds to the alertness level of human subjects.

Publications:

The research has just entered the stage where it is justifiable to publish some of our findings. Hence no publications have been generated, but two are now in preparation.

1. Phasic EEG event Detectors
2. Detection of Spike-like activity in the EEG.

When these papers are completed, preprints will be sent to the AFOSR.

INSTRUMENT INTERFACING

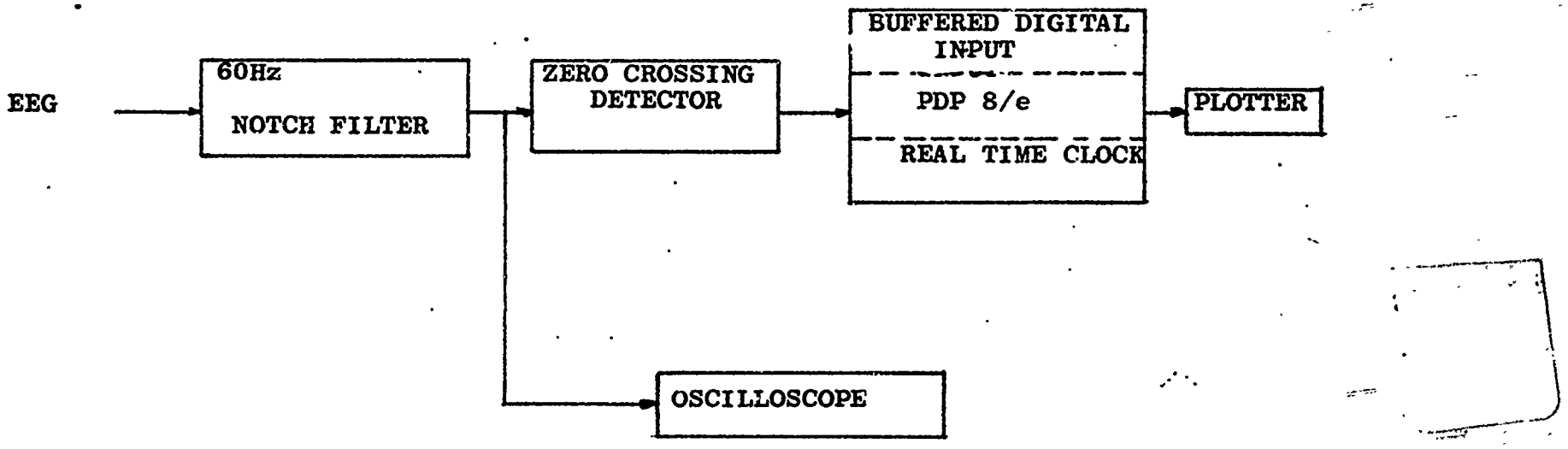

FIGURE 1